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Kootenai County, Idaho

National Eutrophication Survey, Las Vegas, Nev

Prepared for

Environmental Monitoring and Support Lab, Las Vegas, Nev

Jul 77

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Report

on

Hayden Lake

Kootenai County

Idaho

EPA Region X

Working Paper No. 781

With the cooperation of the

Idaho Department of Health and Welfare

and the

Idaho National Guard

July, 1977

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16. ABSTRACT

Annual total phosphorus and total nitrogen loadings to the lake were estimated and subdivided according to either point or non-point source origin. An assessment of the lake's trophic condition and limiting nutrient is also provided. All data collected by the U.S.E.P.A. National Eutrophication Survey during the one year study of the lake and its tributaries are included in the report.

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KOOTENAI COUNTY, IDAHO

EPA REGION X

by

National Eutrophication Survey

Water and Land Quality Branch
Monitoring Operations Division
Environmental Monitoring & Support Laboratory
Las Vegas, Nevada

and

Special Studies Branch
Corvallis Environmental Research Laboratory
Corvallis, Oregon

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OFFICE OF RESEARCH AND DEVELOPMENT
U.S. ENVIRONMENTAL PROTECTION AGENCY

July 1977

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FOREWORD

The National Eutrophication Survey was initiated in 1972 in response to an Administration commitment to investigate the nationwide threat of accelerated eutrophication to freshwater lakes and reservoirs.

OBJECTIVES

The Survey was designed to develop, in conjunction with state environmental agencies, information on nutrient sources, concentrations, and impact on selected freshwater lakes as a basis for formulating comprehensive and coordinated national, regional, and state management practices relating to point source discharge reduction and nonpoint source pollution abatement in lake watersheds.

ANALYTIC APPROACH

The mathematical and statistical procedures selected for the Survey's eutrophication analysis are based on related concepts that:

a. A generalized representation or model relating sources, concentrations, and impacts can be constructed.

b. By applying measurements of relevant parameters associated with lake degradation, the generalized model can be transformed into an operational representation of a lake, its drainage basin, and related nutrients.

c. With such a transformation, an assessment of the potential for eutrophication control can be made.

LAKE ANALYSIS

In this report, the first stage of evaluation of lake and watershed data collected from the study lake and its drainage basin is documented. The report is formatted to provide state environmental agencies with specific information for basin planning [§303(e)], water quality criteria/standards review [§303(c)], clean lakes [§314(a,b)], and water quality monitoring [§106 and §305(b)] activities mandated by the Federal Water Pollution Control Act Amendments of 1972.

Beyond the single lake analysis, broader based correlations between nutrient concentrations (and loading) and trophic condition are being made to advance the rationale and data base for refinement of nutrient water quality criteria for the Nation's freshwater lakes. Likewise, multivariate evaluations for the relationships between land use, nutrient export, and trophic condition, by lake class or use, are being developed to assist in the formulation of planning guidelines and policies by the U.S. Environmental Protection Agency and to augment plans implementation by the states.

ACKNOWLEDGMENTS

The staff of the National Eutrophication Survey (Office of Research and Development, U.S. Environmental Protection Agency) expresses sincere appreciation to the Idaho Department of Health and Welfare for professional involvement, to the Idaho National Guard for conducting the tributary sampling phase of the Survey, and to those Idaho wastewater treatment plant operators who provided effluent samples and flow data.

The staff of the State of Idaho Department of Health and Welfare, Division of Environment, provided invaluable lake documentation and counsel during the Survey, reviewed the preliminary reports and provided critiques most useful in the preparation of this Working Paper Series.

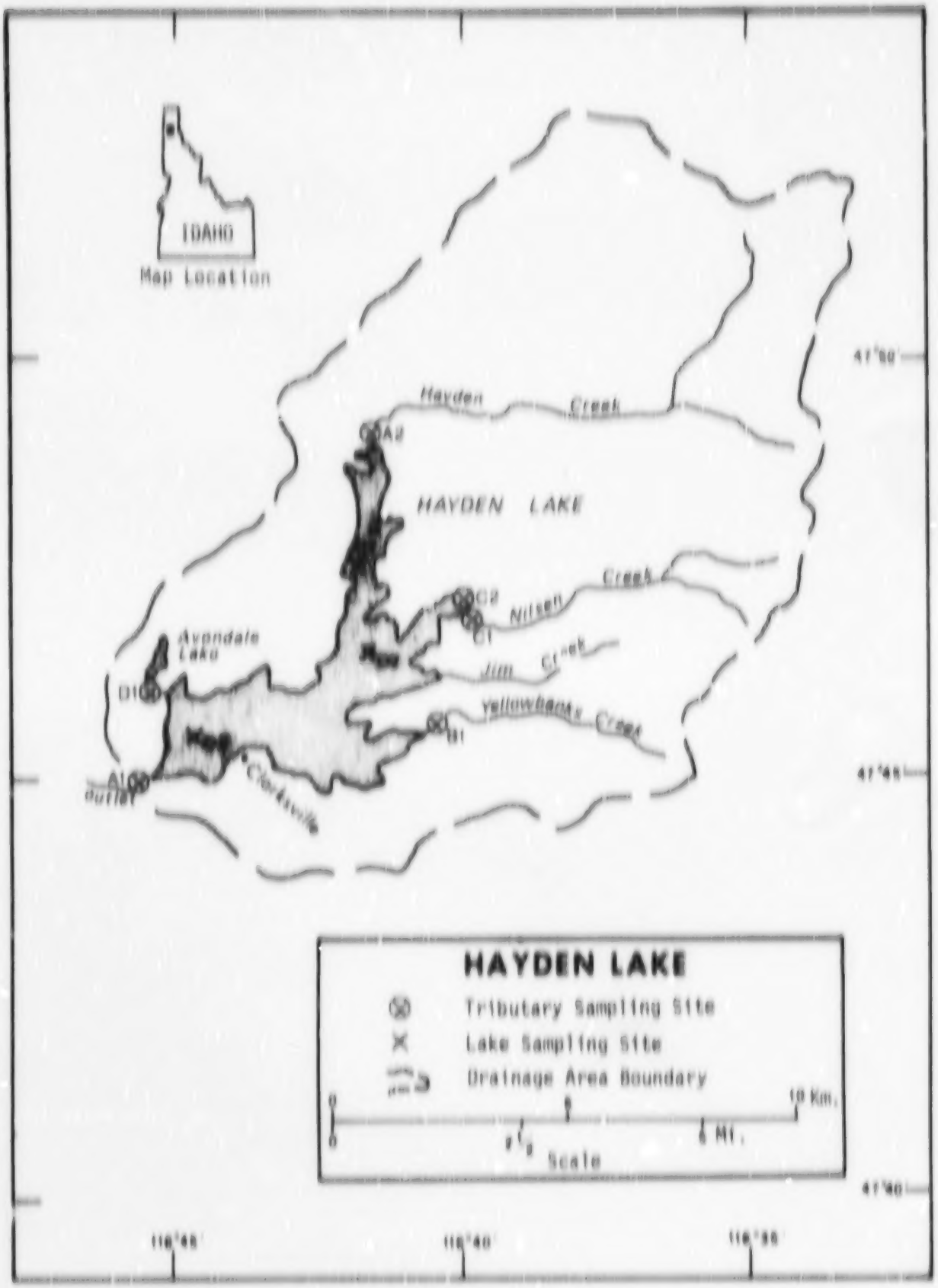
Major General James S. Brooks, Adjutant General of Idaho, and Project Officer Major Vestal L. Baker, who directed the volunteer efforts of the Idaho National Guardsmen, are also gratefully acknowledged for their assistance to the Survey.

NATIONAL EUTROPHICATION SURVEY

STUDY LAKES

STATE OF IDAHO

LAKE NAME	COUNTY
American Falls Reservoir	Bannock, Bingham, Power
Cascade Reservoir	Valley
Coeur d'Alene Lake	Benewah, Kootenai
Dworshak Reservoir	Clearwater
Hauser Lake	Kootenai
Hayden Lake	Kootenai
Island Park Reservoir	Fremont
Lake Lowell (Deer Flat Reservoir)	Canyon
Magic Reservoir	Blaine, Camas
Palisades Reservoir	Bonneville (Lincoln in WY)
Payette Lake	Valley
Lower Twin Lake	Kootenai
Upper Twin Lake	Kootenai


IDAHO
Map Location
HAYDEN LAKE
Hayden Creek
Nilsen Creek
Jim Creek
Yellowbanks Creek
Avondale Lake
Outlet
Coeur d'Alene
A2
C2
C1
B1
D1
A1
41°50'
41°45'
41°40'
116°48'
116°40'
116°35'
HAYDEN LAKE
Tributary Sampling Site
Lake Sampling Site
Drainage Area Boundary
0
10 Km.
0
6 Mi.
Scale

REPORT ON HAYDEN LAKE, IDAHO

STORET NO. 1606

I. CONCLUSIONS

A. Trophic Condition:*

Survey data indicate that Hayden Lake is early mesotrophic. Chlorophyll a values in the lake ranged from 1.8 µg/l in the fall to 4.6 µg/l in the spring with a mean of 2.8 µg/l. Potential for primary production as measured by algal assay control yield was moderately low in the spring sample (04/04/75) and high in the fall (09/10/75) sample. Lake water transparency was excellent. Of the 13 Idaho lakes sampled in 1975, 11 had higher median total phosphorus values (0.010 mg/l), 11 had higher median inorganic nitrogen levels (0.040 mg/l), and all had higher median ortho-phosphorus (0.003 mg/l) values than Hayden Lake.

Survey limnologists did not report any problem conditions during their visits to the lake. The Idaho Department of Water Resources, et al. (1975), however, report existing pollution due to residential development, irrigation return and inadequate sewage systems.

*See Appendix I.

B. Rate-Limiting Nutrient:

The algal assay results indicate that Hayden Lake was phosphorus limited at the time of sampling (04/04/75, 09/10/75). Lake data indicate phosphorus limitation in the spring and fall, and nitrogen limitation in the summer.

C. Nutrient Controllability:

1. Point sources -

There were no known municipal or industrial point sources impacting Hayden Lake during the sampling year. Septic tanks were estimated to account for 12.0% of the total phosphorus load to the lake.

2. Nonpoint sources -

Hayden Creek contributed 28.8%, Hokins Creek contributed 15.0%, and the ungaged tributaries and immediate drainage contributed an estimated 24.1% of the total phosphorus loading to Hayden Lake.

The Idaho District Office of the U.S. Geological Survey (Bill Harenburg, personal communication) reports that all water in Hayden Lake either seeps out through the lake bottom or is pumped out for irrigation. Therefore, no information is available on the outflow of nutrients, and the net nutrient accumulation in Hayden Lake cannot be determined. Additional sampling

is needed to determine the true nutrient budget for the lake before recommendations on nutrient controllability can be made.

II. LAKE AND DRAINAGE BASIN CHARACTERISTICS

Lake and drainage basin characteristics are itemized below. Lake surface area, mean depth and volume were provided by Herman Ray (personal communication). Maximum depth was estimated on the basis of National Eutrophication Survey (NES) data. Tributary flow data were provided by the Idaho District Office of the U.S. Geological Survey (USGS). Outlet drainage area includes the lake surface area. Precipitation values are estimated by methods as outlined in NES Working Paper No. 175. A table of metric/English conversions is included as Appendix A.

A. Lake Morphometry:

1. Surface area: 17.00 km^2.
2. Mean depth: 7.3 meters.
3. Maximum depth: 54.2 meters.
4. Volume: 123.349 x 10^6 m^3.
5. Mean hydraulic retention time: ?

B. Tributary and Outlet:
(See Appendix B for flow data)

1. Tributaries -

Name	Drainage area (km^2)	Mean flow (m^3/sec)
A-2 Hayden Creek	73.0	0.91
C-1 Mukins Creek	20.2	0.25
D-1 Avondale Lake Outlet	6.5	0.07
Minor tributaries and immediate drainage -	44.9	0.77
Totals	144.4	2.00

2. Outlet - A-1 Irrigation ditch 161.4 ----

C. Precipitation:

1. Year of sampling: 86.1 cm.
2. Mean annual: 84.2 cm.

III. LAKE WATER QUALITY SUMMARY

Hayden Lake was sampled three times during the open-water season of 1975 by means of a pontoon-equipped Huey helicopter. Each time, samples for physical and chemical parameters were collected from three stations on the lake and from a number of depths at each station (see map, page v). During each visit, depth-integrated samples were collected from each station for chlorophyll *a* analysis and phytoplankton indentification and enumeration. During the first and last visits, 18.9-liter depth-integrated samples were composited for algal assays. Maximum depths sampled were 20.1 meters at Station 01, 52.7 meters at Station 02, and 51.8 meters at Station 03. For a more detailed explanation of NES methods, see NES Working Paper No. 175.

The results obtained are presented in full in Appendix C and are summarized in III-A for waters at the surface and at the maximum depth for each site. Results of the phytoplankton counts and chlorophyll *a* determinations are included in III-B. Results of the limiting nutrient study are presented in III-C.

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[illegible] AND CHEMICAL CHARACTERISTICS

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B. Biological Characteristics:

1. Phytoplankton -

Sampling Date	Dominant Genera		Algal Units per ml
06/04/75	1.	Dinobryon	510
	2.	Melosira	198
	3.	Asterionella	170
	4.	Ankistrodesmus	113
	5.	Cyclotella	113
		Other genera	58
		total	1,162
07/23/75	1.	Dinobryon	333
	2.	Cyclotella	212
	3.	Anabaena	30
	4.	Ankistrodesmus	30
		Other genera	***
		total	605
09/10/75	1.	Stephanodiscus	80
	2.	Chroomonas	32
	3.	Aphanothece	16
		Other genera	***
		total	128

2. Chlorophyll a -

Sampling Date	Station Number	Chlorophyll a (ug/l)
04/04/75	01	4.6
	02	3.3
	03	3.2
07/23/75	01	---
	02	1.3
	03	2.6
09/10/75	01	1.6
	02	2.0
	03	2.1

C. Limiting Nutrient Study

1. Autoclaved, filtered, and nutrient spiked -

a. 04/04/75

Spike (mg/l)	Ortho P Conc. (mg/l)	Inorganic N Conc. (mg/l)	Maximum Yield (mg/l-dry wt.)
Control	0.005	0.020	0.2
0.05 P	0.055	0.020	1.3
0.05 P + 1.0 N	0.055	1.020	21.1
1.00 N	0.005	1.020	0.2

b. 09/10/75

Spike (mg/l)	Ortho P Conc. (mg/l)	Inorganic N Conc. (mg/l)	Maximum Yield (mg/l-dry wt.)
Control	0.015	0.055	1.5
0.05 P	0.065	0.055	6.9
0.05 P + 1.0 N	0.065	1.055	35.4
1.00 N	0.015	1.055	1.6

2. Discussion -

The control yields of the assay alga, Selenastrum capricornutum, indicate that the potential for primary production was moderately low in Hayden Lake during the spring sampling (04/04/75) and high during fall sampling (09/10/75). The increase in growth yield beyond that of the control caused by the addition of phosphorus, as well as the lack of response to the addition of nitrogen indicates phosphorus limitation in both assays. Maximum yield over that of the control was achieved with the simultaneous addition of both phosphorus and nitrogen.

The mean inorganic nitrogen to orthophosphorus (N/P) ratios for the spring, summer, and fall sampling were approximately 20/1, 5/1, and 14/1, respectively, suggesting phosphorus limitation in the spring and fall and nitrogen limitation in the summer (a mean N/P ratio of 14/1 or greater generally reflects phosphorus limitation).

IV. NUTRIENT LOADINGS
(See Appendix D for data)

For the determination of nutrient loadings, the Idaho National Guard collected monthly near-surface grab samples from each of the tributary sites indicated on the map (page v), except for the high runoff month of June when two samples were generally collected. Sampling was begun in October 1974, and was completed in August 1975.

Through an interagency agreement, stream flow estimates for the year of sampling and a "normalized" or average year were provided by the Idaho District Office of the USGS for the tributary sites nearest the lake.

In this report, nutrient loads for sampled tributaries were determined by using a modification of a USGS computer program for calculating stream loadings. Nutrient loads indicated for tributaries are those measured minus known point source loads, if any.

Nutrient loadings for unsampled "minor tributaries and immediate drainage" ("ZZ" of USGS) were estimated by using the mean annual nutrient loads, in kg/km^2/year, for Hayden Creek and Indian Creek at Stations A-2 and C-1 and multiplying the means by the ZZ area in km^2.

A. Waste Sources:

1. Known municipal - None

2. Known industrial - None

B. Annual Total Phosphorus Loading - Average Year:

1. Inputs -

Source	kg P/yr	% of total
a. Tributaries (nonpoint load) -		
A-2 Hayden Creek	430	28.8
C-1 Hoskins Creek	225	15.0
D-1 Avondale Lake Outlet	---	----
b. Minor tributaries and immediate drainage (nonpoint load) -	360	24.1
c. Known municipal STP's - None		
d. Septic tanks* -	180	12.0
e. Known industrial - None		
f. Direct precipitation** -	300	20.1
Totals	1,495	100.0

2. Outputs - A-1 Irrigation ditch ----

3. Net annual P accumulation - 1,495

*Estimate based on 627 lakeshore residences, 1 park and 1 camp.
**Estimated (See OECD Working Paper No. 175).

C. Annual Total Nitrogen Loading - Average Year:

1. Inputs -

Source	kg N/yr	% of total
a. Tributaries (nonpoint load) -		
A-2 Hayden Creek	13,990	22.6
C-1 Mokins Creek	8,815	14.2
D-1 Avondale Lake Outlet	------	----
b. Minor tributaries and immediate drainage (nonpoint load) -	14,055	22.7
c. Known municipal STP's - None		
d. Septic tanks* -	6,785	10.9
e. Known industrial - None		
f. Direct precipitation** -	18,355	29.6
Totals	62,000	100.0
2. Outputs - A-1 irrigation ditch	------	
3. Net annual N accumulation -	62,000	

*Estimate based on 627 lakeshore residences, 1 park and 1 camp.
**Estimated (See NES Working Paper No. 175).

D. Mean Annual Nonpoint Nutrient Export by Subdrainage Area:

Tributary	kg P/km^2/yr	kg N/km^2/yr
A-2 Hayden Creek	6	190
C-1 Hokins Creek	11	436

E. Mean Nutrient Concentrations in Ungaged Streams:

Tributary	Mean Total P (mg/l)	Mean Total N (mg/l)
B-1 Yellowbanks Creek	0.016	2.100

F. Yearly Loading:

	Total Yearly Phosphorus Loading (g/m^2/yr)
Estimated loading for Hayden Lake	0.09

V. LITERATURE REVIEWED

Harenburg, William. 1976. Personal Communication. (Water Outflow from Hayden Lake) U.S. Geological Survey, Boise, Idaho.

Idaho Department of Water Resources, Department of Health and Welfare, Department of Fish and Game, and Department of Budget, Policy Planning and Coordination. 1975. Idaho Environmental Overview. Boise, Idaho.

Ray, Herman. 1976. Personal communication (morphometric data of selected Idaho water bodies). Boise, Idaho.

U.S. Environmental Protection Agency. 1975. National Eutrophication Survey Methods 1973-1976. Working Paper No. 175. National Environmental Research Center, Las Vegas, Nevada, and Pacific Northwest Environmental Research Laboratory, Corvallis, Oregon.

VI. APPENDICES

APPENDIX A
CONVERSION FACTORS

CONVERSION FACTORS

Hectares x 2.471 = acres

Kilometers x 0.6214 = miles

Meters x 3.281 = feet

Cubic meters x 8.107×10^{-4} = acre/feet

Square kilometers x 0.3861 = square miles

Cubic meters/sec x 35.315 = cubic feet/sec

Centimeters x 0.3937 = inches

Kilograms x 2.205 = pounds

Kilograms/square kilometer x 5.711 = lbs/square mile

APPENDIX B

TRIBUTARY FLOW DATA

APPENDIX C

PHYSICAL AND CHEMICAL DATA

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APPENDIX D

TRIBUTARY AND WASTEWATER TREATMENT PLANT DATA

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APPENDIX E

PARAMETRIC RANKINGS OF LAKES SAMPLED BY NES IN 1975

STATE OF IDAHO

Mean or median values for six of the key parameters evaluated in establishing the trophic conditions of Idaho lakes sampled are presented to allow direct comparison of the ranking, by parameter, of each lake relative to the others. Median total phosphorus, median inorganic nitrogen and median dissolved orthophosphorus levels are expressed in mg/l. Chlorophyll a values are expressed in ug/l. To maintain consistent rank order with the preceding parameters, the mean Secchi disc depth, in inches, is subtracted from 500. Similarly, minimum dissolved oxygen values are subtracted from 15 to create table entries.

LAKE DATA TO BE USED IN RANKINGS

LAKE CODE	LAKE NAME	MEDIAN TOTAL P	MEDIAN INCHG N	SUM- MEAN SEC	MEAN CHLOR	15- MIN SD	MEDIAN SESS SECCHI D
1601	AMERICAN FALLS RESERVOIR	0.105	0.030	413.000	15.379	34.700	0.035
1602	COCOLALLA LAKE	0.032	0.060	425.067	8.001	34.900	0.059
1603	LAKE COEUR D'ALENE	0.017	0.045	380.342	18.391	12.200	0.025
1604	[illegible] RESERVOIR	0.010	0.090	401.096	2.420	7.400	0.009
1605	[illegible]	0.020	0.075	386.296	11.112	34.000	0.013
1606	HAYDEN LAKE	0.010	0.040	243.500	2.707	11.000	0.003
1607	ISLAND PARK RESERVOIR	0.034	0.050	391.770	4.327	12.000	0.012
1608	LAKE LOWELL	0.070	0.070	477.111	25.304	34.000	0.015
1609	MAGIC RESERVOIR	0.062	0.130	400.750	7.322	34.700	0.020
1610	PALISADES RESERVOIR	0.024	0.090	345.420	2.067	12.000	0.007
1611	LOWER PAYETTE	0.013	0.060	234.000	4.000	9.000	0.007
1612	LOWER TWIN LAKES	0.016	0.050	370.000	2.300	13.000	0.009
1613	UPPER TWIN LAKES	0.017	0.045	389.342	4.000	8.200	0.004

PERCENT OF LAKES WITH HIGHER VALUES (NUMBER OF LAKES WITH HIGHER VALUES)

LAKE CODE	LAKE NAME	MEDIAN TOTAL P	MEDIAN INORG N	SUB-MEAN SEC	MEAN CHLORA	15-MIN 10	MEDIAN DISS INTHC P
1001	AMERICAN FALLS RESERVOIR	8 (8)	17 (1)	8 (1)	8 (1)	21 (2)	8 (8)
1002	CASTAIC LAKE	33 (4)	54 (6)	17 (2)	42 (5)	4 (8)	50 (5)
1003	LAKE CHELAN DARLENE	67 (8)	96 (11)	50 (6)	25 (3)	67 (8)	83 (10)
1004	CRESCENT RESERVOIR	96 (11)	17 (1)	25 (3)	63 (10)	100 (12)	50 (5)
1005	[illegible]	42 (5)	33 (4)	75 (9)	17 (2)	4 (8)	25 (3)
1006	HAYDEN LAKE	96 (11)	96 (11)	92 (11)	75 (9)	75 (9)	100 (12)
1007	ISLAND PARK RESERVOIR	25 (3)	71 (8)	42 (5)	33 (4)	54 (6)	33 (4)
1008	LAKE LOWELL	8 (1)	42 (5)	8 (8)	8 (8)	33 (4)	17 (2)
1009	MAGIC RESERVOIR	17 (2)	8 (8)	33 (4)	50 (6)	21 (2)	8 (1)
1010	PALISADES RESERVOIR	50 (6)	17 (1)	83 (10)	100 (12)	54 (6)	75 (9)
1011	UPPER PAYETTE	83 (10)	54 (6)	100 (12)	67 (8)	83 (10)	67 (8)
1012	UPPER TWIN LAKES	75 (9)	71 (8)	50 (7)	92 (11)	42 (5)	50 (5)
1013	UPPER TWIN LAKES	50 (7)	83 (10)	67 (8)	50 (7)	92 (11)	92 (11)